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from the total weight the small amount of base assumed to exist as bicarbonate, corresponding to the excess of CO_2 shown by analysis, and making also the very probable assumption that the calcium found replaces the magnesium in the triple salt, we should obtain very nearly the same results as before; but such a calculation would rest on uncertain data, and add nothing to the strength of our general conclusion.

It is evident that the crystalline scale is a double carbonate of magnesium and sodium united in molecular proportions with common salt, and mixed with a small amount of impurity; but the amount of impurity is very small, considering the conditions under which the scale is formed. That the chloride is combined, and not simply mixed, with the carbonate, is shown, not only by the definite proportions, but also by the fact that the material is so slowly acted on by water, which evidently acts as a decomposing agent, and not solely as a solvent. The scale is then a definite crystalline product, having a very interesting constitution not unlike that of several well defined mineral species.

III.—ON THE CONSTANCY IN THE HEAT PRODUCED BY THE REACTION OF ARGENTIC NITRATE ON SOLUTIONS OF METALLIC CHLORIDES.

BY THEODORE W. RICHARDS, A. B. 1886.

HAVING observed in some experiments made solely for practice that the heat produced by the precipitation of silver chloride from aqueous solutions of several metallic chlorides was directly proportional to the amount of silver nitrate used, the following investigation was made in order to determine whether this relation was really exact.

A standard solution of argentic nitrate was prepared by dissolving 100 grams of AgNO_3 in one litre of water, and diluting to 1250 cc. 50 cc. of this solution diluted to just 250 cc. were used in each determination (except once when twice that amount was used), and the solutions of the various chlorides were made up so that 250 cc. would contain a gram or so more salt than was necessary to precipitate the quantity of silver nitrate used.

As the investigation was a question of comparison rather than of absolute measures, great care was taken to render the conditions as uniform as possible. For this purpose, all the solutions and apparatus were left for twenty-four hours in a room of nearly constant temperature before being used.

The calorimeter was similar in every respect to that described by Berthelot, and the method of operation was exceedingly simple. In every case 250 cc. of the solution of the metallic chloride were poured into the platinum calorimeter, and at the same time 250 cc. of the silver solution (containing 4 grams of AgNO_3 as stated above) were poured into a beaker, which had a capacity when filled to the brim of 255 cc. The beaker was rested upon many folds of a non-conducting cloth, and surrounded by a cardboard cylinder with a movable cover.

When the temperatures of the liquids in both the calorimeter and the beaker (which were at first very nearly the same) had become constant after much stirring, they were noted, and the beaker was grasped by a heavily gloved hand and its contents poured rapidly into the calorimeter, the temperature of the resulting mixtures being noted.

Following is an example taken at random from the note-book.

Temperature of NH_4Cl sol. in calorimeter	. 17°.220
“ “ AgNO_3 sol. in beaker	. . . 17°.280
Mean 17°.250
Final observed temperature 18°.000
Rise of temperature 0°.750

In every case the maximum temperature was attained in 10 to 15 seconds, so that no correction for cooling was necessary.

The water equivalent was always as follows:—

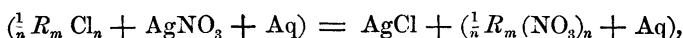
Solutions, 500 grms.; platinum calorimeter, 3.5 grms.; platinum stirrer, 1.5 grms.; thermometer, 5 grms. Total water equivalent = 505.5 grms.

Below is a table of all the results found.

The first column contains the number of the experiment, the second the chloride acted upon, the third the observed rise of temperature, and the fourth the amount of heat evolved in calors, and the last column the difference between the amount in each case and the average amount.

		°		
1	Sodic Chloride NaCl	.760	} 16,220	+65
2	" " "	.750		
3	Potassic Chloride KCl	.750	} 16,110	-55
4	" " "	.750		
5	Ammonic Chloride NH ₄ Cl	.755	} 16,170	+5
6	" " "	.750		
7	Barium Chloride BaCl ₂	.750	16,110	-55
8	Cupric Chloride CuCl ₂	.757	16,270	+115
9	Zinc Chloride ZnCl ₂	.760	16,320	+165
10	Manganese Chloride MnCl ₂	.745	16,010	-155
11	Nickel Chloride NiCl ₂	.755	} 16,110	-55
12	" " "	.745		
13	Ferrous Chloride FeCl ₂	.745	16,010	-155
14	Aluminic Chloride Al ₂ Cl ₃	.745	16,010	-155
15	Ferric Chloride Fe ₂ Cl ₃	1.520*	} 16,320	+165
16	" " "	.760		
17	Chromic Chloride Cr ₂ Cl ₃	.760	16,320	+155
18	Hydrochloric Acid HCl	.760	} 16,170	+5
19	" " "	.740		
20	" " "	.755		
	Average	.7526	16,165	

It will be seen that all of these results are identical within the limit of error of the process. We may, therefore, draw the conclusion, that the amount of heat evolved by the reaction thus represented,



is constant, no matter what R , m , or n may be.

Hence, also, *the difference between the heats of formation of equivalent amounts of nitrate and chlorides in aqueous solution is the same for any metal or basic radical.*

IV.—IS THERE A CONSTANT RELATION BETWEEN THE HEATS OF FORMATION OF CHLORIDES AND SULPHATES IN AQUEOUS SOLUTION?

By IRVING W. FAY, A. B. 1886.

THE series of results obtained by Mr. Richards, as above described, suggested the inquiry whether a like constant relation might not be found between the heats of formation of the *chlorides* and *sulphates* in

* In this experiment 8 grms. of AgNO₃ were used.